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RESEARCH MEMORANDUM

MEASUREMENTS OF AILERON EFFECTIVENESS OF THE BELL X-1 AIRPLANE

AT MACH NUMBERS BETWEEN 0.9 AND 1.06

By

Hubert M. Drake

CLASSIFICATION CHANGED TO
Langley Aeronautical Laboratory
Langley Air Force Base, Va.

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RESEARCH MEMORANDUM

MEASUREMENTS OF AILERON EFFECTIVENESS OF THE BELL X-1 AIRPLANE

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SUMMARY

Abrupt rudder-fixed aileron rolls have been made with the Bell X-1 airplane in powered flight at Mach numbers between 0.90 and 1.06 at about 40,000 feet pressure altitude.

These aileron rolls indicate that the aileron effectiveness for large deflections at $M = 0.94$ is only one-fourth the value at $M = 0.82$, and the effectiveness at $M = 1.06$ is slightly greater than at $M = 0.94$.

INTRODUCTION

The present program of flight research on the X-1 airplane having the 10-percent-thick wing is to determine the aileron effectiveness in the Mach number range from 0.80 to 1.1. Data on the aileron effectiveness to a Mach number of 0.82 have been presented in reference 1. The present report presents results of aileron rolls performed at Mach numbers between 0.90 and 1.06.

SYMBOLS

p	rolling angular velocity, radians per second
b	wing span, feet
V	true airspeed, feet per second
M	Mach number
δ_a	total aileron deflection, degrees

AIRPLANE AND INSTRUMENTATION

The general dimensions of the Bell X-1 airplane used in the NACA transonic research program are given in figure 1. Detailed physical characteristics are tabulated in reference 2.

The ailerons of the X-1 have a span of 5.8 feet, a chord 15 percent of the wing chord, and an area of 3.5 square feet per aileron. The root mean square chord is 0.565 foot; the trailing-edge angle is $11\frac{1}{2}^\circ$; and the deflection, $\pm 12^\circ$.

During the aileron rolls, records were taken on standard NACA instruments of altitude, airspeed, rolling angular velocity, three components of acceleration, sideslip angle, and the positions of two ailerons, the elevator, and rudder. All records were synchronized by a common timer.

TEST RESULTS AND DISCUSSION

The aileron rolls were made in level flight or in a very gradual climb with rocket power on. Rolls were made at each Mach number by abruptly moving the ailerons from the trim position to some position approaching full deflection and holding this position until the rolling velocity reached a maximum value. The rudder was held fixed. All rolls were made at an altitude of about 40,000 feet.

The variation of $\frac{pb/2V}{\delta_a}$ with Mach number is presented in figure 2.

The values obtained at Mach numbers below 0.82 and presented in reference 1 are also shown. These data indicate that the aileron effectiveness at $M = 0.94$ decreases to a value of about one-fourth of that value at $M = 0.82$. The single point obtained at $M = 1.06$ indicates there may be a slight increase in effectiveness as the Mach number is increased above 1. There has been no indication of reversal of effectiveness in the Mach number range between 0.94 and 1.06 although data in this range are lacking. Aileron forces in these rolls were light on the order of 20 pounds.

Data were obtained at $M = 0.94$ for a large deflection of the ailerons (17° total) and for a small deflection (6° total) as noted in figure 2. As might be expected, the effectiveness is considerably reduced at small deflections in this Mach number region.

CONCLUSIONS

From aileron rolls made at Mach numbers between 0.90 and 1.06, it is concluded that the aileron effectiveness for large deflections at a Mach number of 0.94 is only one-fourth the effectiveness at a Mach number of 0.82 and the effectiveness at Mach number 1.06 is slightly greater than at Mach number 0.94.

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National Advisory Committee for Aeronautics
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2. Williams, Walter C., Forsyth, Charles M., and Brown, Beverly P.: General Handling-Qualities Results Obtained during Acceptance Flight Tests of Bell XS-1 Airplane. NACA RM L8A09, 1948.

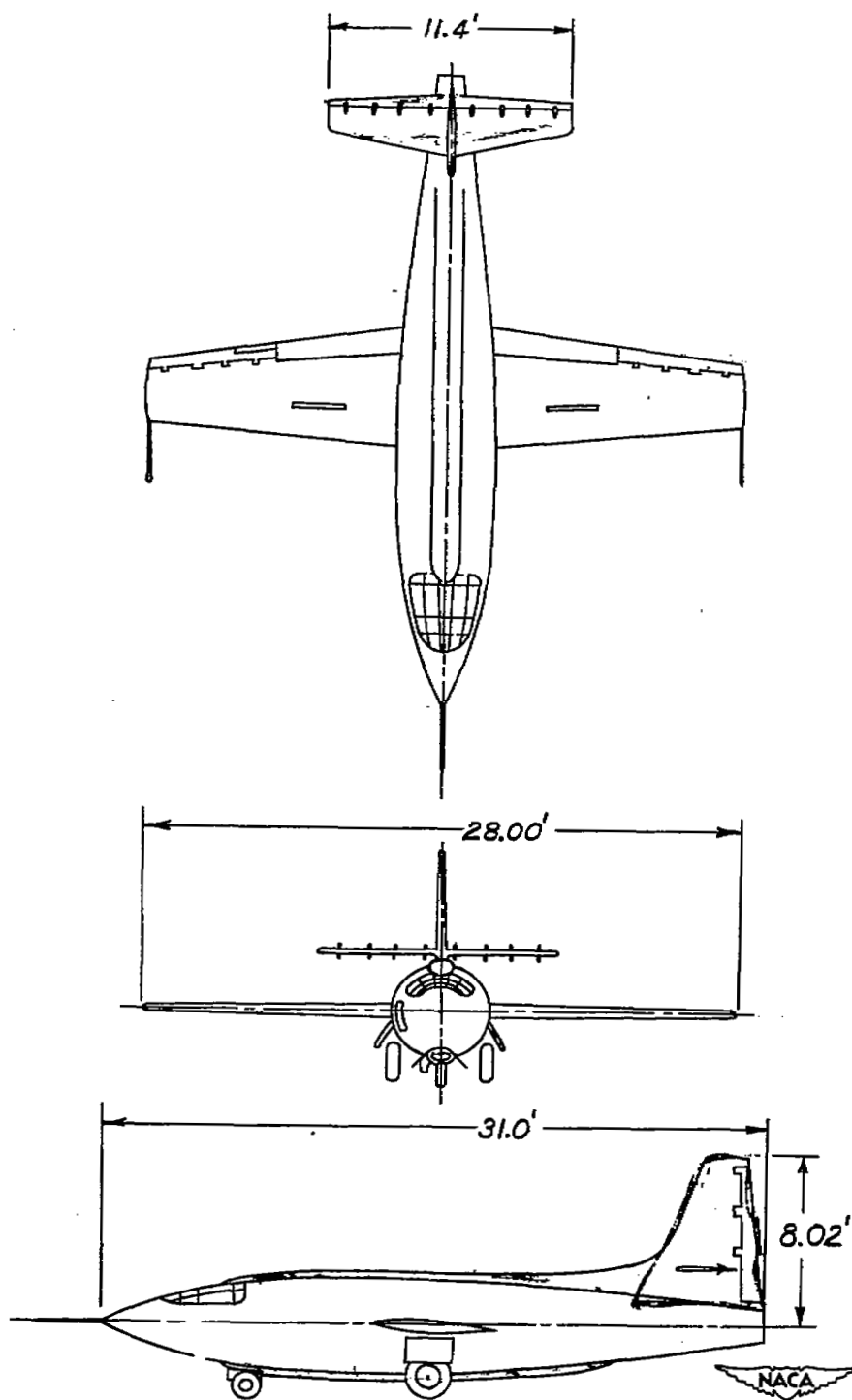
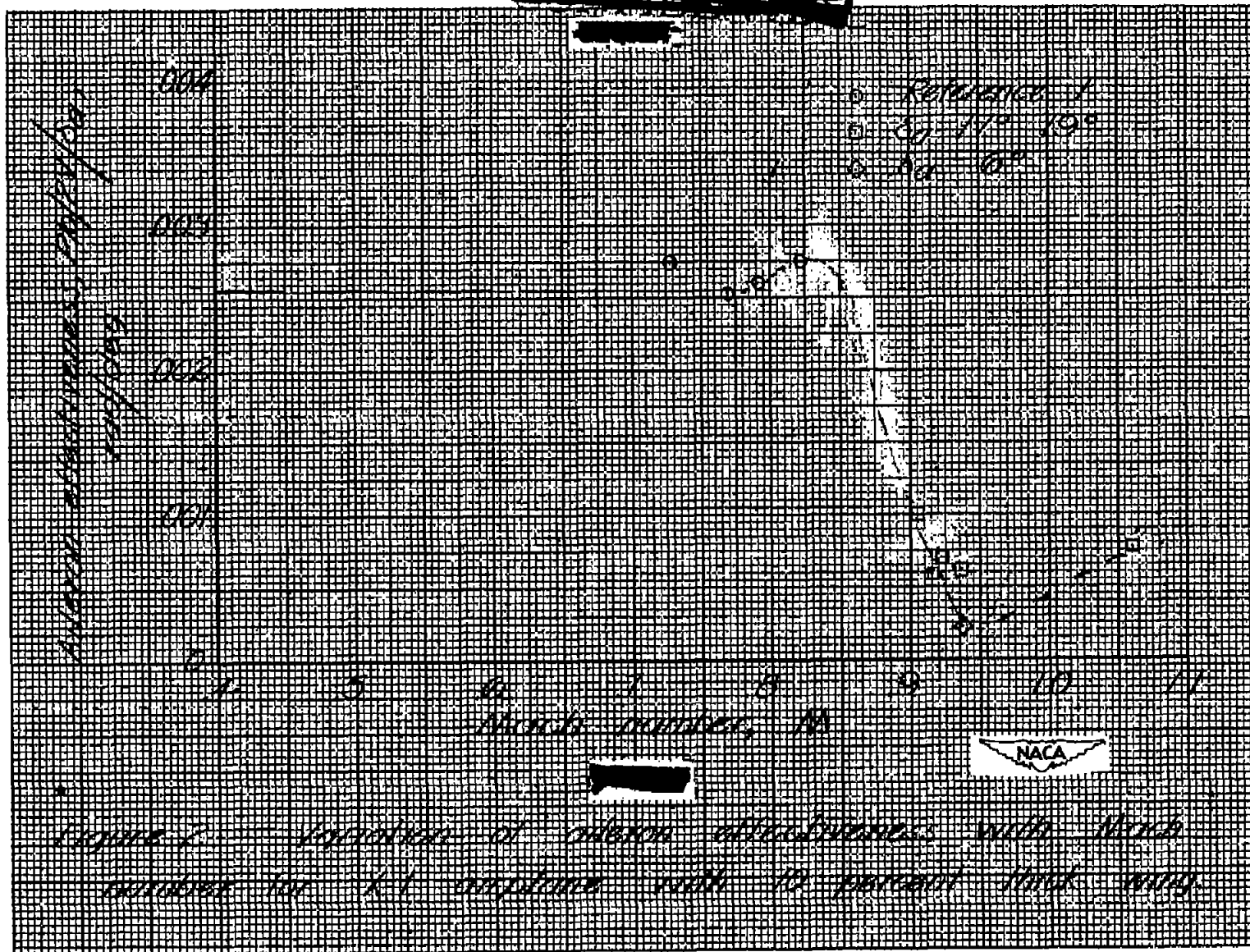


FIGURE 1.-THREE-VIEW DRAWING. X-1 AIRPLANE



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ABSTRACT

Presents results of flight measurements of aileron effectiveness of the X-1 airplane up to a Mach number of 0.94. The data indicate a 75 percent loss of aileron effectiveness between $M = 0.82$ and $M = 0.94$.